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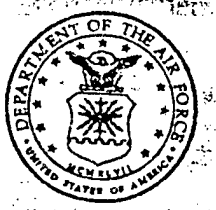

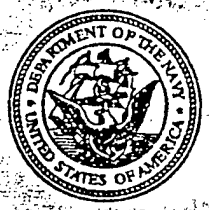

CALS Test Network Testing Philosophy

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CTN Testing Philosophy

1 Introduction

The Department of Defense (DoD) initiated Computer-Aided Acquisition and Logistics Support (CALS) Program has the overall goal to enable and accelerate the use and integration of digital technical information for weapons system design, acquisition, manufacture, and support. The successful completion of this goal will result in reduced acquisition and support costs for weapons systems, improved quality and timeliness of technical information, and improved responsiveness of the industrial base for system design and manufacture.

One objective of the CALS Program is to accelerate the development and testing of digital data interchange and access standards. The development of digital interchange standards is well under way with the implementation of MIL-STD-1840A, Automated Interchange of Technical Information, and the adoption as military standards subsets of several existing national and international standards, IGES: MIL-D-28000, SGML: MIL-M-28001, Raster: MIL-R-28002, and CGM: MIL-D-28003. Additional data interchange and access standards are also under development.

The testing of these CALS standards is being performed through the creation of a DoD and Industry distributed CALS Test Network (CTN) under the direction of the Air Force. The overarching goal of the CTN is to demonstrate, test, and evaluate the interchange and functional use of digital technical information between industry and Government using CALS Standards. This comprehensive testing program will assure that these standards are being correctly implemented, that computer products of different vendors will work together, and that the CALS standards have the capability and effectiveness to satisfy the information interchange and access requirements associated with the design, acquisition, manufacture and support of weapons systems.

The purpose of this paper is to discuss the testing philosophy and approach of the CTN. Since there are many views of testing, it is necessary to present a brief discussion, from a CALS perspective, of what is meant by the several types of testing. This discussion is given in Section 2. Once there is an understanding of types of testing that can occur, a discussion of the testing approach and philosophy of the CTN is given in Section 3. A summary is presented in Section 4.

2 Testing

The purpose of this section is to present a brief discussion of the several types of testing that can occur to gain a consistent understanding of the terms used to identify CTN testing. This discussion will form the basis for discussing the testing philosophy and approach of the CTN. The types of testing that will be discussed are: Development, Operational, Verification and Validation, Conformance, Acceptance, Prototyping, and Demonstrations. The several scales of testing include: bench scale, laboratory scale, and field scale. These scales will be discussed first.

Scales of Testing

Bench scale testing occurs with a limited amount of resources available to examine and assess the object being tested. This scale of testing received its name from the fact that all the resources needed to perform the test could fit on the surface of a workbench. With respect to data interchange standards, this is analogous to testing the standards on a single piece of equipment that is used as both a sending and receiving translator. That is, determining whether digital data can be formatted into standard forms on an output media from a particular computer and then able to be read by the same computer.

Laboratory scale testing occurs within a closed, controlled environment and can consist of testing an enhanced or larger version of the object that has undergone bench scale testing. This testing can also involve several types of equipment that can be used to examine and assess the object being tested. With respect to digital data standards, this scale of testing is analogous to testing the standards on several computers that are located within close proximity, that have their operating characteristics well understood, and are controlled using digital data that fully exercises the extent of the standard being tested.

Field scale testing occurs within an environment that approximates the conditions under which the object will be expected to operate. This scale of testing allows the examination of full scale objects within the actual environment for which they were developed. The field scale testing of digital data interchange standards involves examining and assessing the use of the standards for digital data transfers among several distributed full scale computer systems and facilities.

Types of Testing

Development Testing occurs during the design and development stage to examine and evaluate the basic concepts and components of the object being developed. This type of testing involves determining the proof of concept of the analytical solutions and the various pieces that form the basis for the object's design and operation. With respect to digital data standards, this type of testing is performed to determine and assess if the individual components of a standard are sufficient to contain and transfer the original information in digital format. In addition, it determines whether the individual pieces work together effectively to form a complete standard.

Operational Testing occurs prior to and/or during the implementation stage and is performed on a fully configured and operational object in both a simulated environment and during actual conditions. This type of testing examines and evaluates the operational ability of the object to perform its intended function. With respect to digital data standards, operational testing determines whether the standard is complete enough and has the capability to transfer the entire range of information for which it is required. This type of testing also determines whether the standard is effective and viable in the facilitation of digital data transfer, access, and storage over the complete range of user requirements.

Verification and Validation: Verification is the review of requirements to see that the right problem is being solved and then a review of the design to see that it meets the requirements. Validation is the test and evaluation of the integrated system to determine compliance with the functional, performance and interface requirements that were verified. With respect to data, validation is testing to confirm that the requirements for the data have been met.

Conformance Testing is the evaluation that certifies that a product or service satisfies specified standards and technical specification as determined through a specified test methodology. Conformance testing utilizes benchmark information to test the complete capability and effectiveness of the product including its limits of applicability.

Acceptance Testing is the process of inspection and evaluation needed to accept a product as the fulfillment of a contract deliverable. Acceptance is the term used by the government that indicates that they take title to the product being delivered.

Prototyping is the process of testing or exhibiting the original or model of the product as an example of its meeting requirements in an operational environment.

Demonstrations provide evidence or proof of the effectiveness and usefulness of a product and examples of how the product performs. A demonstration exhibits a product's functional capabilities.

3 CTN Testing Philosophy and Approach

The overall goal of the CTN is to demonstrate and test the interchange of technical information using the CALS Standard MIL-STD-1840A. The CTN has established an informal confederation of industry, DoD/government, Services, and national laboratories to perform distributed end-to-end testing of the CALS standards. Before we discuss the objectives and approach of CTN testing, the following gives a brief discussion of the end-to-end digital data interchange process.

3.1 Digital Data Interchange

The digital data interchange (DDI) process involves the transfer of technical information from an originating facility to a receiving facility in digitized form. This data interchange process is illustrated in Figure 1. The digital data interchange process is similar to the process currently being used to transfer technical information using reproducible film or aperture cards. Some of the steps are the same. However, the use of digital data for transfer presents several differences, and provides a means to improve the process and make it more efficient and effective.

Data is created at the originating facility during component design, development, testing, and manufacture. This information is created in a format consistent with the originating facility's attributes and requires quality assurance/quality control (QA/QC) measures and inspections for technical accuracy and content. When the data is ready for transfer, it is translated by the sending system into a standard format that is acceptable to the receiving facility.

Following data translation, the deliverable is inspected and certified that the digital information conforms to the standard format specified for transfer, and is readable and complete. As part of this digital data QA/QC process, the originating agency's capability (hardware, software and procedures) to translate data into the format that conforms to the standard can be tested and certified through the application of conformance testing by an outside agency.

The transfer process involves the creation of files in standard format on transferable media. Presently the medium specified by MIL-STD-1840A is 9-track magnetic tape. However, transfers by floppy disk, telecommunication, and optical media are being considered.

The process of receiving information in digital form involves the inspection and certification that the data is acceptable as the completion of a deliverable product. This acceptance process determines data completeness and whether the data meets the specified transfer format for compatibility with the receiving facility. The receiving facility may use the data in this standard form or translate it using a post-processor to their native form. The post-processor translation process (hardware, software and procedures) can also be tested to determine whether it can receive and translate data that conforms to the standard.

Now that the data has been accepted and is in the native form of the receiving facility, it is ready to be used to fulfill the mission for which it was created.

The details of the digital data interchange process depends on several factors including:

1. the type of data being transferred (text, drawing, database),

2. the application for which the data is being delivered, and

3. the physical attributes of the originating and receiving facilities, and

4. the digital format being used for the transfer.

The type of data being transferred will indicate which CALS standard will be used to transfer the data. For instance, CAD/CAM data will be transferred using MIL-D-28000, IGES. The combination of the data application and the physical attributes of the originating and receiving facilities will indicate how the standards are going to be used and the media used for the transfer.

3.2 CTN Objectives and Approach

The CTN efforts involve demonstrating the complete digital data interchange process over the full range of user applications and testing the CALS standards within this process. The CTN will perform a combination of development and operational testing in a field scale environment. The demonstrations and tests will utilize the distributed resources of the CTN participants and include the complete end-to-end interchange between industry and government facilities, industry and industry facilities, and government and government facilities.

The objectives of the CTN testing are:

1. Demonstrate the capabilities and operation of the CALS standards over the complete range of user applications.

2. Evaluate the capability and effectiveness of the CALS standards for digital data interchange.

3. Identify any needed improvement to the standards.

4. Identify the need and requirements for new digital data standards.

5. Perform prototype Conformance Testing needed to certify that hardware and software produce digital data that conforms to the CALS standards contained in MIL-STD-1840A.

6. Assist in the development and prototyping of Acceptance Testing needed for the inspection and acceptance of digital data supplied as the fulfillment of a contract deliverable.

7. Provide guidance for use of the CALS standards within the user applications.

Demonstrating the capabilities and operation of the CALS standards will give the user community, including industry and government facilities alike, confidence that the standards can be utilized as a viable means to transfer technical information in digital form. With this confidence, these facilities can implement their usage of the standards and gain the benefits of using data in digital form.

There are various types of applications that will utilize digital data interchange. These applications can be categorized into the three broad groups listed below:

Technical Publications	-textual documents and manuals that include tables, figures and illustrations
Engineering Data	-two and three dimensional engineering drawings used for design, construction and manufacture; the complete specification of a product
Logistics/Analysis Data	-statistical, mathematical and descriptive data used to record performance, physical properties and calculated attributes

MIL-STD-1840A is applicable to all these categories and the military standards presently specified for use within each broad category are:

Technical Publications	MIL-D-28000, IGES Class I MIL-M-28001, SGML MIL-R-28002, Raster Type 1 MIL-D-28003, CGM
Engineering Data	MIL-D-28000, IGES Class II, III, and IV MIL-R-28002, Raster Type I and II PDES (not presently specified but under development)
Logistic/Analysis Data	MIL-STD-1388-2B, 3A, LSA/LSAR, SQL

The CTN will be testing the capability of the standards to determine if they contain sufficient attributes to be able to transfer and access the information necessary for product design, acquisition, manufacture, use, and support. This testing is directed at assessing whether each standard has sufficient breadth to cover the complete range of information needs and applications. However, each standard cannot be so large that it is difficult to maintain sending and receiving translators that will allow conformance to the entire standards. Otherwise compatibility between disparate systems may not be possible.

Testing the effectiveness of the standards involve assessing whether they are adequate to accomplish digital data transfer, are correctly implemented, and are ready for use by industry and government. This testing is also directed at assessing whether the standards are efficient by allowing cost-effective and timely information transfer and access with an acceptable level of manpower expenditure.

The results of the CTN testing will lead to improvements to the CALS standards. These improvements include:

1. Recommendations for upgrades and revisions to the National and/or International Standards which are the basis for these military standards. These recommendations are directed at the basic elements or structure of the standards.

2. Recommendations for upgrades and revisions to the military standards. These recommendations will be directed at how the standards work in DoD applications and environments.

In addition, the results of CTN Testing will provide data on the limitations and applicability of sending and receiving translators that can be used to help these systems conform to the military standards.

A well defined set of standards will enhance the efforts of CALS and the digital data interchange process. Insights gained through CTN testing will help identify requirements for new standards to foster this enhancement. This has already occurred. MIL-STD-1840A specifies digital data delivery by 9-track tape. However, there have been discussions of digital data interchange via floppy disk and optical media. While the floppy media conforms to a standard similar to magnetic tape, there is no standard for writing optical media. In addition, there needs to be a standard for the file structures that will reside on these media analogous to that indicated by MIL-STD-1840A for tape.

When formal conformance testing methods and techniques are developed by the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards, the CTN will perform prototype testing of this process using end-to-end transfers between industry and government CTN participants. The results of this prototype testing will be used to validate and finalize this process for use by an outside agency.

Presently, there are procedures in place to accept technical data as part of a deliverable product. The CTN, in coordination with NIST, will develop a digital data acceptance process based in part on these procedures. However, the delivery of digital data may pose different problems and there may be automated methods to enhance delivery inspection and certification. The CTN plans to rely on the efforts of the Services' test beds to address the process, prototyping, and testing of digital data acceptance procedures and methods.

As CTN demonstration and testing proceeds, the expertise developed and experience gained throughout the network will be used to provide guidance on how to use the CALS standards. This guidance may be in the form of functional specifications or handbooks, and can provide government and industry CTN participants advice on hardware, software and procedures that may be employed to have the capability to both send and receive data consistent with MIL-STD-1840A.

In addition, the tools developed by CTN to test and evaluate the standards will be made available to all CTN participants. However, proprietary tools used by CTN will not be available for distribution.

3.3 CTN Testing Approach

The CTN testing approach provides for the fulfillment of the project goals and objectives. The CTN is developing the capability to perform tests utilizing reference data and actual design and production information through both structured testing and naturally occurring experiments.

The development of a testing capability includes developing general test plans and procedures to conduct tests, transfer testing software to facilitate an automated test capability, and testing evaluation procedures for analyzing the results of data transfers. Reference data is being developed that exercises the full capability of the standards. This reference data will be used in structured tests to evaluate the capability and effectiveness of the standards as a medium for transmission of digital technical information. Actual design and production data that would be used in normal digital data transfers will also be used in the CTN testing to gather information on the applicability and usefulness of the standards.

CTN Structured tests are formally planned and scheduled digital data transfers between end-to-end CTN participants utilizing fully characterized test facilities and reference data for the specified CALS standard being tested. These structured digital data transfers will be technically analyzed so that a detailed evaluation of the CALS standards and the pre- and post-processors can be performed.

Naturally occurring experiments are normal digital data transfers using actual data in the CALS related standards formats. The CTN will ask to observe these data transfers to obtain information concerning the applicability of the standards during actual conditions. The level of CTN involvement in these tests will depend on the end-to-end participants and can range from asking the participant to provide qualitative information concerning these transfers, to hands-on CTN participation in the transfer utilizing reference data.

The general test procedure is illustrated in Figure 2. Test data in hard form is provided to the originating participant, who is asked to translate this information into a digital format utilizing an appropriate CALS standard. The hard data could be an engineering drawing, illustration and/or technical manual. The originating participant is asked to provide the digitized data on a 9-track tape in MIL-STD-1840A format.

In a structured test, two tapes would be made, one for evaluation by the appropriate CTN test platform and the other sent to the receiving test participant. The CTN digital tape is analyzed at the test platform, and reference data on magnetic tape is then transferred to the receiving facility. The data on both tapes are translated to the native format utilized at the receiving facility and analyzed by CTN.

During a naturally occurring experiment, actual data is used in the transfer. The intermediate step of tape analysis by the CTN test platform may or may not be performed depending upon the agreement between the test participants and CTN.

Before any tests are conducted, a proposed test plan is developed that identifies and describes the test objectives, the test procedure, and the participating facilities. For those tests requiring funding, the test plans will be reviewed by the CTN Review Board for approval prior to the test initiation.

3.4 CTN Test Beds

As CTN testing expands to include the complete spectrum of DoD facilities and industry contractors, there is a potential to exceed the testing capability and resources of the CTN Test Platform. Therefore, the CTN is establishing lead DoD agency Test Beds to focus the CTN efforts within their respective agencies. Lead DoD CTN Test Beds will be established at Air Force, Army, Navy and Defense Logistic Agency (DLA) facilities. In addition, since the Department of Energy (DOE) is also responsible for the design and development of weapon systems, a DOE CTN Test Bed will be established.

The CTN Test Platform will develop a testing capability, reference data, test plans, and procedure for use in CTN testing and help to establish these capabilities at the CTN Test Beds. The CTN Test Beds will be the focus of the CTN efforts at their respective agency by performing actual tests, coordinating tests within their agency, performing prototype conformance and/or acceptance tests, and providing assistance to testing being performed within their respective agency. In addition, as these test beds gain experience in the use and testing of the CALS standards, they can provide assistance to their agency facilities on how to establish a digital data interchange capability.

4.0 Summary of CTN Testing Philosophy and Approach

The overall goal of the CTN is to demonstrate the complete digital data interchange process and test the CALS standards within this process. The CTN has established an informal network of DoD/government, industry, Service, and national laboratory participants to perform distributed end-to-end transfer testing of the CALS standards. This virtual network of magnetic tape, optical media, and telecommunications will utilize the combined resources of the CTN participants to test the standards in user applications. These applications include transfers of technical publications, engineering drawings and product data, and the use of share distributed data bases.

The CTN will perform a combination of development and operational testing to demonstrate and evaluate the capability and effectiveness of the CALS standards. It will test the standards to see if they provide proper media for digital data interchange, are correctly implemented, and are ready for use. Structured testing and naturally occurring experiments will encompass representative aspects of the transfer process utilizing reference data and actual design and production information. The CTN testing will also include prototype conformance and acceptance testing.

To assist in CTN testing and provide a focal point for testing at the government agencies, lead CTN Test Beds will be established. These test beds will coordinate and conduct testing of the CALS standards, and provide assistance on establishing a CALS capability within their respective agency.

The results of CTN testing will be used to identify improvements to the CALS standards, national/international standards, and problems with sending and receiving translator systems. As the testing proceeds, the CTN will also identify the need for new digital data interchange standards. In addition, the expertise and experience gained through CTN testing will be available to provide guidance on the use of the standards to the entire government and industry communities.

Digital Data Interchange Process

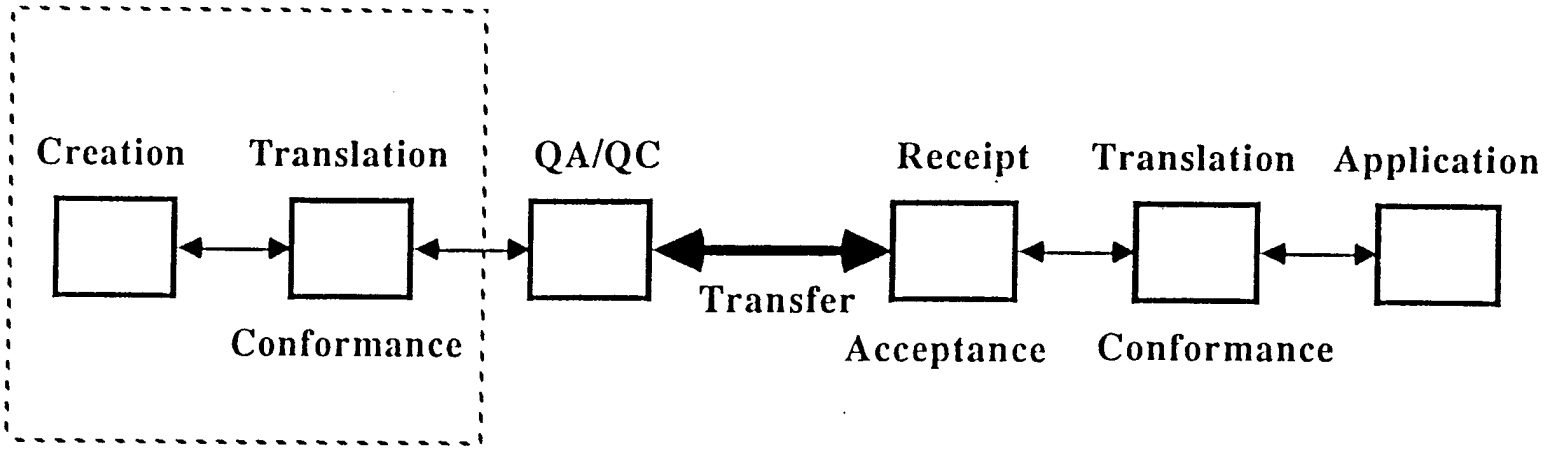

Figure 1

General Test Procedure

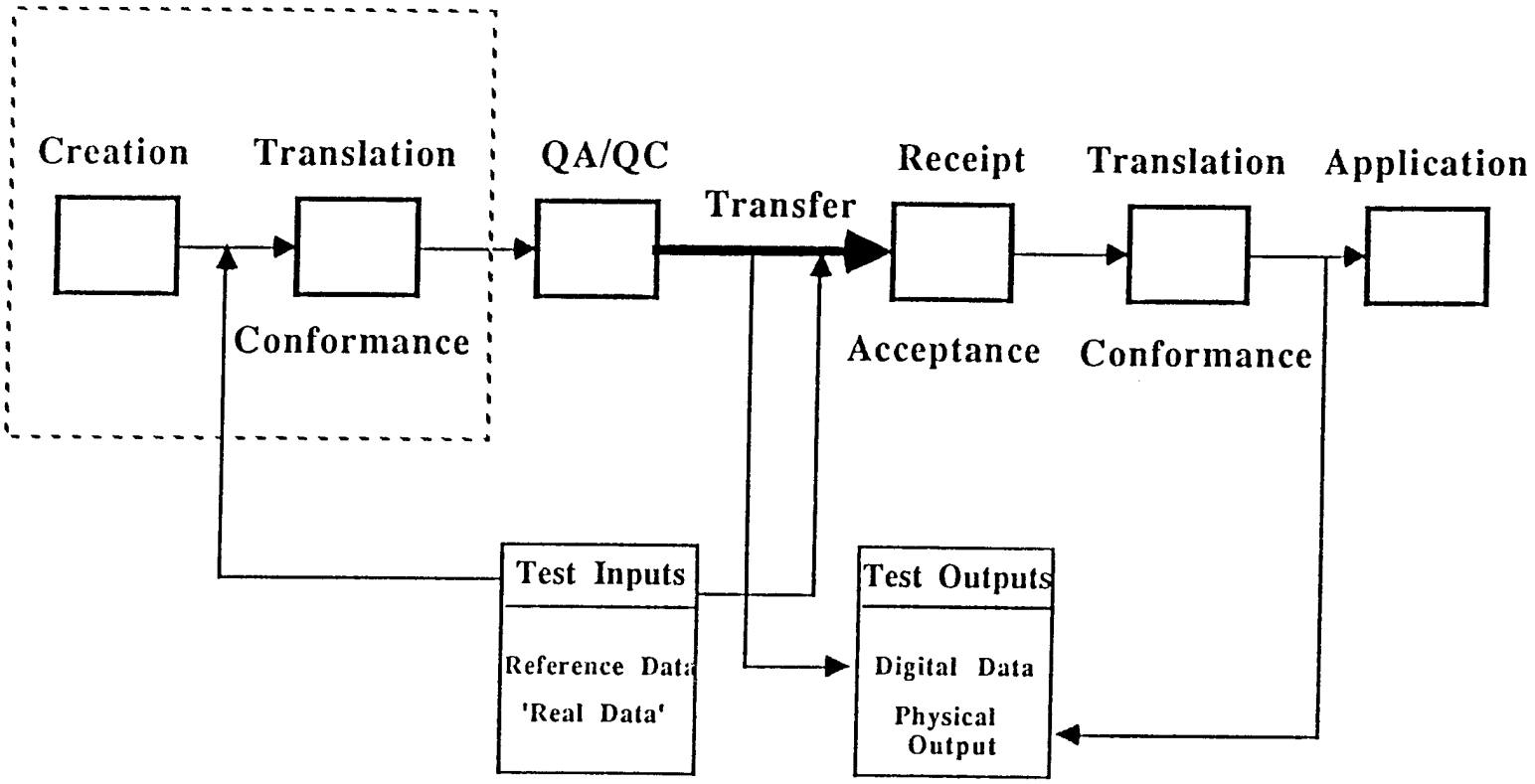

Figure 2